



2811

PATENT
Customer No. 22,852
Attorney Docket No. 08038.0024

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Noriaki FUKIAGE

Serial No.: 09/657,055

Filed: September 7, 2000

For: SEMICONDUCTOR DEVICE HAVING
MULTILAYER INTERCONNECTION
STRUCTURE AND METHOD OF
MAKING THE SAME

Group Art Unit: 2811

Examiner: H. Vu

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

REQUEST FOR RECONSIDERATION

In response to the Office Action dated April 23, 2003, Applicant respectfully requests that the Examiner reconsider the present application and withdraw the claim rejection for the reasons explained below.

As an initial matter, Applicant wishes to express sincere appreciation to the Examiner for the courtesy extended to Applicant's representative during the personal interview held on July 21, 2003. The following remarks reflect subject matter discussed during the interview.

Claims 1-5 and 15-18 are pending in this application, with claims 1, 5, and 15 being independent claims. Claims 6-13 have been withdrawn from further consideration by the Examiner. No claim has been amended.

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In the Office Action dated April 23, 2003, the Examiner rejected claims 1-5 and 15-18 under 35 U.S.C. § 103(a) as being unpatentable over Lopatin (U.S. Patent No. 6,144,096) in view of Gesheva et al. (Ceramics International 22 (1996), pp. 97-89).

Applicant respectfully traverses this rejection.

Each of the claims is drawn to a combination of elements that is patentable over the asserted combination of Lopatin and Gesheva et al. In particular, independent claim 1 recites, among other things, "a crystalline film containing tungsten, carbon, and nitrogen [...] arranged between [an] insulator film and [a] wiring layer." Independent claim 5 recites, among other things, "[a] crystalline film formed of a material comprising tungsten, carbon, and nitrogen, [...] arranged between the insulator film and the wiring layer." Independent claim 15 recites, among other things, "a WC_xN_y crystalline film formed on the insulator," and "a wiring layer of copper formed on the crystalline film, wherein the crystalline film prevents copper diffusion from the wiring layer to the insulator film." As will be detailed below, neither Lopatin nor Gesheva et al., taken either singularly or in combination, teaches or suggests the claimed invention.

Lopatin discloses a barrier/adhesion layer for semiconductors having conductive materials of Cu, Ag, or Au (i.e., Group IB elements). Lopatin specifically discloses that a barrier layer (124, 204) made of a Group VIIIB element alloyed with a small amount of a Group VB or VIB element has increased barrier effectiveness and lower resistivity for a semiconductors having conductive materials of Group IB element. Lopatin, however, does not teach or suggest, among other things, a crystalline film containing tungsten, carbon, and nitrogen for preventing copper diffusion from the wiring layer to the insulator film, as recited in claim 1, "[a] crystalline film formed of a material comprising

tungsten, carbon, and nitrogen, [...] arranged between the insulator film and the wiring layer," as recited in claim 5, and "a WC_xN_y crystalline film formed on the insulator," and "a wiring layer of copper formed on the crystalline film," as recited in claim 15.

While admitting the deficiency of Lopatin (e.g., lack of disclosure for a crystalline film containing tungsten, carbon, and nitrogen or a WC_xN_y crystalline film), the Examiner asserts that "it would have been obvious [...] to form the device of Lopatin having the crystalline film containing tungsten, carbon, and nitrogen between the insulator and the cobalt layer, such as taught by Gesheva et al. in order to prevent the diffusion of cobalt and the wiring into the insulator film." Applicant respectfully disagrees with the Examiner's reasoning for the following reasons.

The Examiner's asserted combination of Lopatin and Gesheva et al. does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103(a). To establish a *prima facie* case of obviousness, three basic criteria must be met. First, the prior art references when combined must teach or suggest all the claim elements. Second, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Finally, there must be a reasonable expectation of success. See M.P.E.P. § 2143.

Furthermore, the teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in Applicant's disclosure. See In re Vaeck, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991). Additionally, the evidence of a teaching, suggestion, or motivation to combine must be "clear and particular." In re Dembiczak, 175 F.3d 994, 999 (Fed. Cir. 1999).

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As explained below, the attempted combination of Lopatin and Gesheva et al. does not establish a *prima facie* case of obviousness under 35 § U.S.C. § 103(a).

In particular, as to the second criterion, there is no suggestion or motivation in either Lopatin or Gesheva et al. to combine or modify the asserted teachings of the references in the manner proposed in the Office Action. For example, the Examiner appears to attempt adding a WC_xN_y film of Gesheva et al. to a semiconductor device of Lopatin between an insulator film and an adhesion layer. The Office Action, however, fails to point out any indication of a suggestion or motivation for making such a modification. Instead, the Examiner merely asserts that the asserted combination is “to prevent the diffusion of cobalt and the wiring [material] into the insulator film.” Applicant respectfully disagrees with the Examiner’s asserted motivation for the combination.

The Examiner’s asserted motivation appears to consist of two parts: (1) “to prevent the diffusion of cobalt [...] into the insulator film,” and (2) “to prevent the diffusion of [...] the wiring [material] into the insulator film.”

Regarding the first part of the Examiner’s asserted motivation, Applicant respectfully submits that there is no suggestion or motivation in either Lopatin or Gesheva et al. that prevention of cobalt diffusion from the adhesion layer of Lopatin is needed, or otherwise desired, in any way. For example, while Gesheva et al. merely discloses that “ WC_xN_y films are the best diffusion barriers for cobalt” (see page 88 of Gesheva et al., right-hand column, lines 16-26), there is no teaching or suggestion in Gesheva et al. that cobalt is used as an adhesion layer in a semiconductor device or is diffused into an insulator film. Geshiva et al. also lacks any suggestion that such a diffusion of cobalt, if it ever does diffuse, is problematic or desirous to be prevented.

Therefore, one of ordinary skill in the art would not have been motivated to make such a modification proposed by the Examiner simply because preventing a diffusion from cobalt was not recognized by either Lopatin or Gesheva et al. In other words, it would not have made any sense for one of ordinary skill in the art to attempt solving a problem, where the problem does not even exist or is not recognized. It appears that the Examiner used an improper hindsight gleaned from the present invention in combining Lopatin and Gesheva et al. to make an obviousness rejection. The Examiner, however, must read the references without such hindsight. When the references of Lopatin and Gesheva et al. are read that way, one of ordinary skill in the art would not have had any reason to combine the asserted teachings of Lopatin and Gesheva et al. since there is no "clear and particular" suggestion or motivation to make the asserted combination or modification.

In addition, the adhesion layer (123, 208) of Lopatin is an optional element, not to mention that the adhesion layer need not necessarily be cobalt, the sole purpose of which is to enhance adhesion of a barrier layer (124, 204) to an insulation layer. If such a cobalt adhesion layer causes a diffusion problem alleged by the Examiner so as to require an additional layer, one of ordinary skill in the art would not have used such a problematic adhesion layer, but instead would have used other disclosed, alternative material (i.e., any other Group VIIIB elements) in place of the cobalt material, or would simply remove the optional adhesion layer.

Furthermore, the Examiner's proposed modification of Lopatin would destroy one of the most important objectives disclosed in that reference. For example, Lopatin discloses an important objective of minimizing the barrier layer thickness, as there is a

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need for minimizing the size of semiconductors. See Lopatin at col. 2, lines 32-54. However, if the semiconductor device of Lopatin is modified in the manner proposed by the Examiner, that modification would increase the thickness of the barrier layer and the electrical resistance. Such increases in the thickness of the barrier layer and the electrical resistance would directly teach away from the above-mentioned objective of Lopatin and violate the teachings of Lopatin.

Regarding the second part of the Examiner's asserted motivation, Applicant respectfully notes that there is no teaching or suggestion in either Lopatin or Gesheva et al. that a WC_xN_y film of Gesheva et al. would "prevent the diffusion of ... the wiring [material] into the insulator film." Nor do those references disclose any plausible reason as to why one of ordinary skill in the art would have been motivated to add another barrier layer into a semiconductor device that already had a barrier layer. As becomes apparent, one of ordinary skill in the art would not have had the knowledge of the benefits or characteristics of a WC_xN_y film as a diffusion preventing layer for copper wiring layer. Without such the knowledge, one of ordinary skill in the art would not have been motivated to use a WC_xN_y film to "prevent the diffusion of ... the wiring [material] into the insulator film."

At least for the reasons set forth above, Applicant respectfully submits that the references of Lopatin and Gesheva et al. fail to establish a *prima facie* case of obviousness under 35 U.S.C. § 103(a). Thus, reconsideration and withdrawal of this rejection is respectfully requested.

In view of the foregoing remarks, the claims define novel and non-obvious subject matter over the cited prior art references. Therefore, Applicant respectfully

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requests the Examiner's reconsideration of the present application, and the timely allowance of all pending claims 1-5 and 15-18.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
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Dated: July 23, 2003

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